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(71) Applicant(s)
Siemens Measurements Limited

(Incorporated in the United Kingdom)

Manchester Road, OLDHAM, Lancashire, OL9 7JS, United Kingdom

(72) Inventor(s)
Timothy John Sheppard
Ian Graham

(74) Agent and/or Address for Service
Derek Allen
Siemens Group Services Limited, Intellectual Property Department, Roke Manor, Old Salisbury Lane, ROMSEY, Hampshire, SO51 0ZN, United Kingdom

(54) A polled communications network

(57) The network comprises a master unit and a plurality of slave units. The master unit is arranged to send messages to, and receive messages from each slave unit. The master unit issues a log-on request message which is received by the slave units, but only the slave units which have not communicated with the master unit before (ie. new slave units) respond to the message. In this way the master unit recognises new slave units connected to the network, enabling the master unit to communicate with them. The network may be used to remotely read electricity meters and automatically recognises when a new meter is connected to the network. Response conflict is avoided using time slots, variable in number, and repetition of the log-on request message. Problems from moving a slave unit to another network can be dealt with using time-outs and master unit identities.

GB 2 272 551 A

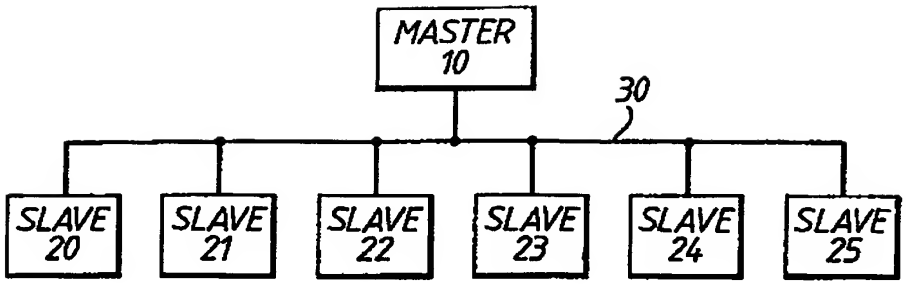
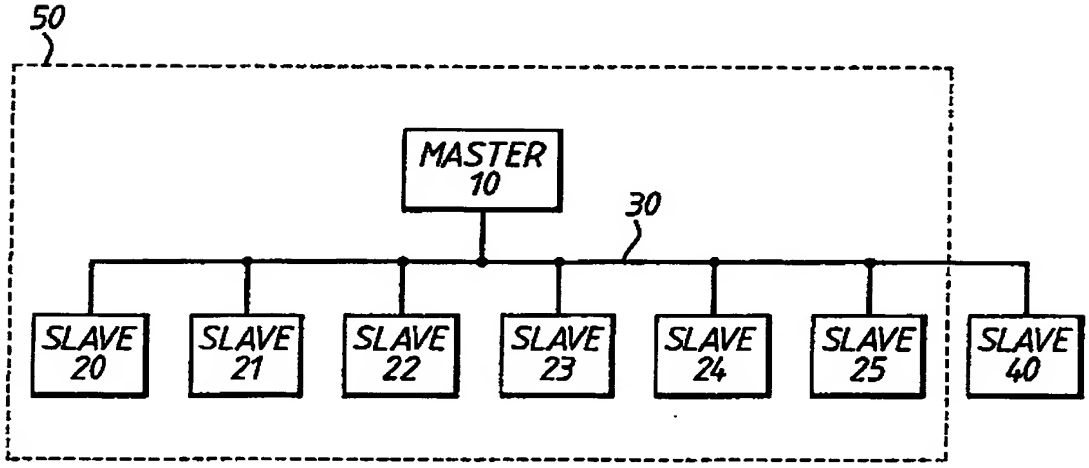

MASTER
10
30
SLAVE
20
SLAVE
21
SLAVE
22
SLAVE
23
SLAVE
24
SLAVE
25

Fig. 1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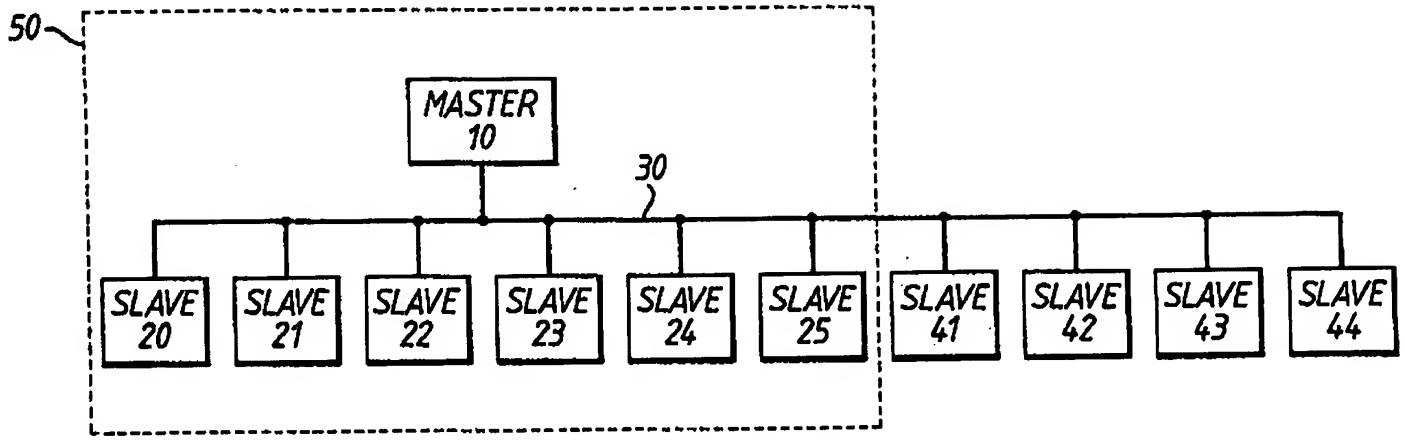
MASTER
10
30
SLAVE
20
SLAVE
21
SLAVE
22
SLAVE
23
SLAVE
24
SLAVE
25
SLAVE
40

Fig. 2


50
MASTER
10
30
SLAVE
20
SLAVE
21
SLAVE
22
SLAVE
23
SLAVE
24
SLAVE
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SLAVE
41
SLAVE
42
SLAVE
43
SLAVE
44

Fig. 3

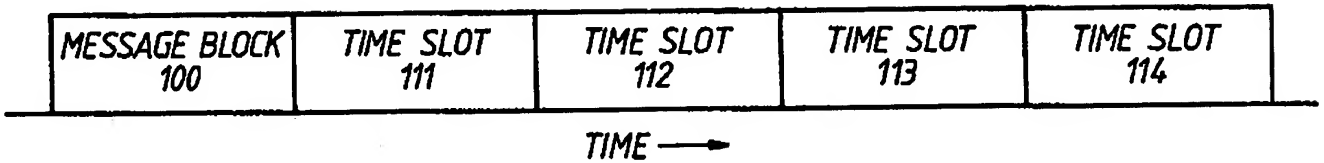
MESSAGE BLOCK
100
TIME SLOT
111
TIME SLOT
112
TIME SLOT
113
TIME SLOT
114
TIME

Fig. 4

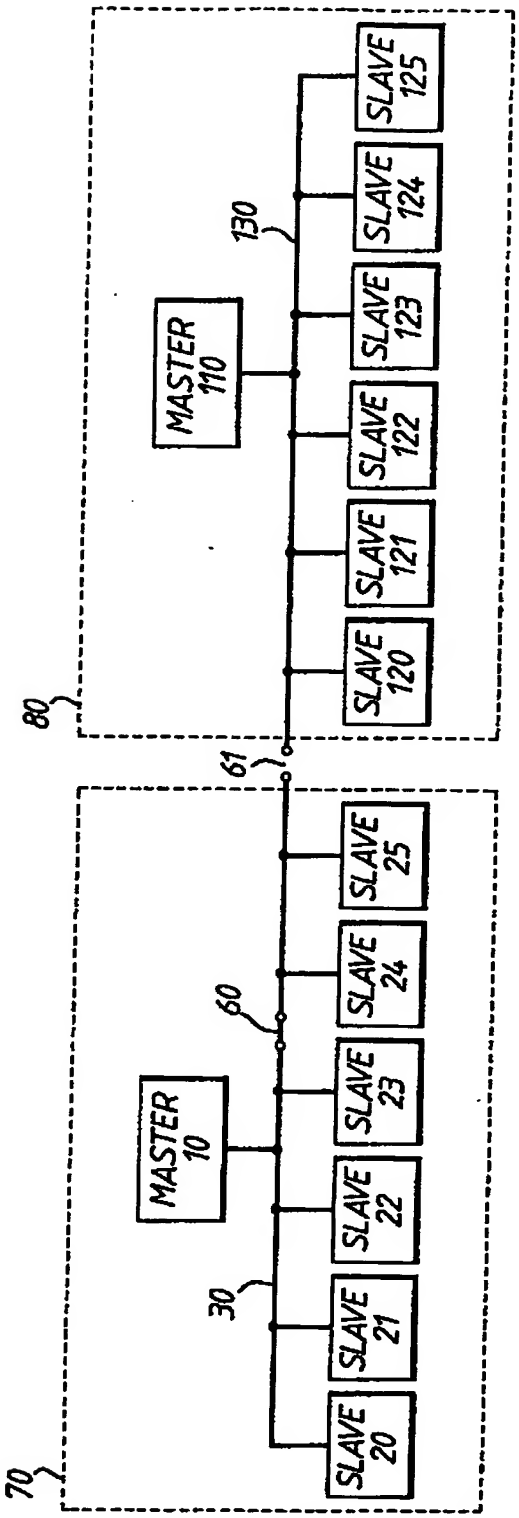
MASTER 10
SLAVE 20
SLAVE 21
SLAVE 22
SLAVE 23
SLAVE 24
SLAVE 25
MASTER 110
SLAVE 120
SLAVE 121
SLAVE 122
SLAVE 123
SLAVE 124
SLAVE 125
30
60
61
70
80
130

Fig. 5

A POLLED COMMUNICATIONS NETWORK

In communications networks where the communications medium is such that not all units can hear messages transmitted by all other units due perhaps to high attenuation or high noise levels such as can occur on mains communications networks, a polled master unit-slave unit architecture is often adopted so that all communications are initiated by the master unit to prevent message collisions.

The disadvantage of such systems is that the master unit must be aware of the existence of each slave unit before communications can take place. Where the network configuration is not fixed and the number of slave units under the control of the master unit can change, the need to inform the master unit of the changes can represent a considerable administrative overhead.

An object of the present invention is to provide means whereby the master unit can automatically detect the presence of a newly installed slave unit and initiate communications with the newly installed slave unit, ie. 'log-on' the newly installed slave unit to the network, without the need for external intervention.

According to the present invention, there is provided a polled communications network comprising a master unit and a plurality of slave units, the master unit being arranged to send messages to, and receive messages from the slave units, characterised in that the master unit is provided with means for issuing a log-on request message which is received by the slave units, and each slave unit is provided with means for responding to the log-on request message, but only responds if the

particular slave unit is newly installed on the network and has not communicated previously with the master unit.

The present invention will now be described with reference to the accompanying drawings in which:

Figure 1 shows a block diagram of a typical communications network incorporating a master unit and a number of slave units;

Figures 2 and 3 respectively show a block diagram of a master/slave communications network with one additional slave unit, and with a plurality of additional slave units;

Figure 4 shows a log-on request message Format; and,

Figure 5 shows two communications networks which may be connected together.

Referring to Figure 1, a simple network with a master unit 10 which controls all communications on the network. A number of slave units 20 to 25 are connected to the master unit 10 for communication therewith. Communication occurs over a communications medium 30 which carries messages between the master unit 10 and the slave Units 20 to 25. In the implementation described, this communications medium 30 is shown as a physical connection although the present invention is equally applicable to other media such as radio.

As in a conventional polled network, the master unit 10 initiates each communication with each of the slave units 20 to 25 either in turn or in accordance with a pre-defined priority or other algorithm. In accordance with the present invention, the master unit 10 will also at intervals issue a log-on request message, which is ignored by all the slave units already in communication with the master unit, ie. logged-on

to the network, but to which any slave unit not yet in communications with the master unit, ie. not yet logged-on to the network, will respond. The response may be in the form of a carrier signal, a modulated carrier signal or a message.

Thus in the example described above, the master unit 10 will issue the log-on request message which is ignored by the slave units already logged-on to the network 20 to 25 and no unit will respond. The master unit 10 therefore knows that there are no newly installed slave units to log-on to the network.

Figure 2 shows the network 50 from Figure 1, with an additional newly installed slave unit 40. In this case, when the master unit 10 issues the log-on request message, the slave units already logged-on to the network 20 to 25 will again ignore it, but the newly installed slave unit 40 will respond. The master unit knows in this case that a newly installed slave unit has been added to the network and it can log-on the newly installed slave unit 40 to the network.

The log-on process will normally vary according to the specific requirements of each application, but will typically involve the following stages:

a) The newly installed slave unit 40 will respond to the log-on request message.

b) The master unit 10 will acknowledge the response and request the identity of the newly installed slave unit 40.

c) The newly installed slave unit 40 will respond with its identity.

d) The master unit 10 will add the newly installed slave unit 40 to its list of units to communicate with, and acknowledges the receipt of

the newly installed slave unit identity.

e) The newly installed slave unit will set an internal marker or flag to inhibit it responding to future log-on request messages.

In some applications of the present invention, additional stages may be added to the log-on process or stages may be combined according to the level of security, reliability and time constraints required by that application. For example, the newly installed slave unit 40 may respond to the log-on request message directly with its identity, thus combining stages a) to c). Alternatively the newly installed slave unit 40 can detect that it has been logged-on to the master unit 10 when the master unit 10 first initiates communications with it. In other applications of the present invention, typically where a large number of similar but isolated communications networks exist and the total number of slave units is large, the master unit 10 may allocate each slave unit an abbreviated identity or address for the purpose of communications efficiency within the network rather than use the full identity of the slave unit. In this case, the master unit 10 will inform the newly installed slave unit 40 of this abbreviated identity as part of the log-on process.

In the case described above, the log-on request message and the response to it do not need any special structure other than being unique messages within the existing communications protocol. However, in many applications of the present invention, more than one newly installed slave unit may be present and in this case all the newly installed slave units would respond to the log-on request message causing message collisions.

The present invention may conveniently be used to avoid such collisions. Referring to Figure 3, a network 50, as in Figure 1, is shown but with four newly installed slave units 41 to 44. If the log-on request message is arranged to have a format as shown in Figure 4, where the master unit 10 transmits the message block 100 of the log-on request message and this is followed by a number of time slots 111 to 115, then the firstly newly installed slave unit 41 can respond in the first time slot 111, the second newly installed slave unit 42 can respond in the second time slot 112 and similarly for the third and fourth newly installed slave units 43 and 44 can respond in the third and fourth time slots 113 and 114. The fifth time slot in this example is not used. In this way the master unit 10 can detect that four newly installed slave units are present.

In this case the acknowledgement from the master unit 10 to each of the four newly installed slave units 41 to 44 should be specific to each slave unit to give a positive log-on of each slave unit. This can be achieved in a number of ways depending on the actual application. If the response to the log-on request message includes the identity of the newly installed slave unit, the master unit 10 can use this directly to address each of the newly installed slave units 41 to 44 in turn. If the response to the log-on request message does not include the identity of the newly installed slave unit, then the master unit 10 can use the number of the time slot 111 to 114 in which each newly installed slave unit responded as a means of addressing the newly installed slave units for the log-on process.

In order for this aspect of the invention to work, the newly installed slave units 41 to 44 have to be instructed in some way as to which time slot to respond in. Since the object of the present invention is to make the log-on of newly installed slave units automatic, this instruction should be of a generic nature and built into each slave unit so that the slave unit can select the correct time slot without external intervention. This selection can be based on some aspect of the slave unit's identity, as in the example described above where the last digit of slave unit's identity defined the time slot, or it can be made on a random or pseudo-random basis.

In either case, if more than one newly installed slave unit is present, there is a finite probability that more than one newly installed slave unit will respond in a particular time slot. The probability can be reduced by increasing the number of time slots following the message block of the log-on request message and this can be optimised to suit the expected maximum number of newly installed slave units which could respond to a log-on request message. For example, in one application of the present invention for remote reading of electricity meters, one hundred or more time slots might be needed to accommodate the initialisation of all the newly installed slave units on a single network.

Increasing the number of time slots to accommodate the expected maximum number of newly installed slave units is, however, inefficient if this maximum condition occurs only rarely and most of the times that the log-on request message is sent by the master unit there are no newly installed slave units or only a small number of them. In such circumstances most of the time slots following the message block of the

log-on request message will not be used and the time taken by these time slots is dead time which could be more effectively used. Also in some applications of the present invention, there may be a requirement to issue the log-on request message frequently in order to detect the presence of newly installed slave units as soon as possible after they are installed.

This dead time can be substantially reduced using another aspect of the present invention where the number of time slots following the message block 100 of the log-on request message is variable rather than fixed as described above. This can be accommodated by including in the message block 100 of the log-on request message information on the number of time slots available for a response. The master unit 10 can now issue on a regular basis log-on request messages with a small number of time slots, which will have a minimal dead time if there are no newly installed slave units to respond. In the event that a large number of newly installed slave units respond, most if not all of the time slots will be used and, on detecting this the master unit 10 can re-issue the log-on request message with a larger number of time slots.

Another aspect of the present invention relates to the case where two or more newly installed slave units respond to the log-on request message in the same time slot, but due to their location on the network, the response from one newly installed slave unit is stronger at the master unit than that from another. This can occur if one newly installed slave unit is close to the master unit and another is further away where the attenuation of the communications medium will cause a weaker signal to reach the master unit. In such cases, the master unit is

likely to hear the newly installed slave unit which has the strongest response and not detect the other newly installed slave unit or slave units responding in the same time slot. To overcome this, the master unit can repeat the log-on request message when a response from one or more newly installed slave units has been received, and the relevant slave units logged-on to the network, to ensure that no other newly installed slave units with weaker signals are being masked.

A final aspect of the present invention relates to its application where a number of adjacent but isolated communications networks exist as illustrated in Figure 5. This shows two similar communications networks, the first network 70 comprising a master unit 10, a number of slave units 20 to 25 with which the master unit 10 is already in communication via their communications medium 30, and the second network 80 comprising a master unit 110, a number of slave units 120 to 125 with which the master unit 110 is already in communication via their communications medium 130. If for example, for reasons unrelated to the operation of the communications on the two networks 70 and 80, the link 60 in the communications medium 30 is opened and the link 61 between the two networks 70, 80 is connected, the two slave units 24, 25 will no longer be able to communicate with their master unit 10. However, since they were already in communication with that master unit 10, they would not normally respond to a log-on request message from the master unit 110 on the new network 80, but that master unit 110 would not be aware of the existence of the slave units 24, 25 and would not initiate communications with them.

This can be resolved if the slave units 24, 25 after a period of time without any communications from their original master unit 10 automatically reset themselves back to the state as if they are newly installed slave units, ie. automatically log-off. The slave units 24, 25 will now respond to a log-on request message from the master unit 110 and be logged-on to the new network 80. Similarly the master unit 10 can, after a similar period of time without any response to its communications with the slaves 24, 25, delete them from its list of slave units to communicate with, ie. log-off the lost slave units 24, 25.

A refinement of this aspect is important if the master units 10, 110 are using abbreviated addressing for the slave units on each network. A finite probability exists that a slave unit which is moved from one network to another has the same abbreviated address on its old network as another on the new network. This would cause a clash between the two slave units with the same abbreviated address. This can be overcome if the two master units 10, 110 have their own identity which is transmitted as part of some or all messages on the network. The slave units which move between networks 24, 25 can now immediately recognise the change of identity between the master unit 110 on the new network 80 and the original master unit 10 on the old network 70, and automatically log-off without waiting for a period of time without communications from the original master unit 10.

It will readily be appreciated by those skilled in the art that there are alternative ways of implementing the present invention, which fall within the spirit and scope of the invention as defined in the following claims.

CLAIMS

1. A polled communications network comprising a master unit and a plurality of slave units, the master unit being arranged to send messages to, and receive messages from the slave units, characterised in that the master unit is provided with means for issuing a log-on request message which is received by the slave units, and each slave unit is provided with means for responding to the log-on request message, but only responds if the particular slave unit is newly installed on the network and has not communicated previously with the master unit.

2. A polled communications network as claimed in Claim 1, wherein the master unit and the slave units communicate on an electricity mains network.

3. A polled communications network as claimed in Claims 1 or 2, wherein the newly installed slave unit responds to the log-on request message until it is addressed by the master unit during network communications.

4. A polled communications network as claimed in Claims 1 or 2, wherein the newly installed slave unit continues to respond to the log-on request message until it is instructed by the master unit that it has been logged-on to the network.

5. A polled communications network as claimed in any preceding Claim, wherein the log-on request message is followed by a plurality of time slots in which the newly installed slave units can respond.

6. A polled communications network as claimed in Claim 5, wherein the newly installed slave units include means to select a time slot in which to respond in dependence of their identity.

7. A polled communications network as claimed in Claim 5, wherein the newly installed slave units includes means to randomly select a time slot in which to respond.

8. A polled communications network as claimed in Claim 5, wherein the newly installed slave units include means to select the time slot in which to respond in dependence on a pseudo-random number.

9. A polled communications network as claimed in any of the Claims 5 to 8, wherein the number of time slots following the log-on request message is varied.

10. A polled communications network as claimed in Claims 5 to 9, wherein the number of time slots following the log-on request message is defined within the log-on request message.

11. A polled communications network as claimed in Claims 9 or 10, wherein the number of time slots following the log-on request message is varied according to the number of time slots in which a response was received in a previous log-on request message.

12. A polled communications network as claimed in Claims 5 to 11, wherein the master unit uses the number of a time slot following the log-on request message to log-on the newly installed slave unit which responded in that time slot.

13. A polled communications network as claimed in Claims 5 to 11, wherein the master unit uses the number of a time slot following the

log-on request message to address the newly installed slave unit which responded in that time slot.

14. A polled communications network as claimed in Claims 5 to 13, wherein the master unit repeats the log-on request message following a response in more than a pre-defined number of time slots of a previous log-on request message.

15. A polled communications network as claimed in Claims 5 to 13, wherein the master unit repeats the log-on request message following a response in more than a pre-defined percentage of the available time slots of a previous log-on request message.

16. A polled communications network as claimed in any preceding Claim, wherein the response from newly installed slave units to the log-on request message is in the form of a carrier signal.

17. A polled communications network as claimed in Claim 16, wherein the carrier signal is modulated.

18. A polled communications network as claimed in any of the Claims 1 to 15, wherein the response from a newly installed slave unit to the log-on request message is in the form of a message which does not identify the newly installed slave unit.

19. A polled communications network as claimed in any of the Claims 1 to 15, wherein the response from a newly installed slave unit to the log-on request message is in the form of a message which includes the identity of the newly installed slave unit.

20. A polled communications network as claimed in any preceding Claim, wherein the master unit repeats the log-on request message following a response to a previous log-on request message.

21. A polled communications network as claimed in any preceding claim, wherein the master unit repeats the log-on request message at intervals.

22. A polled communications network as claimed in any preceding Claim, wherein the master unit issues each newly installed slave unit with an abbreviated address during the log-on process for subsequent communications.

23. A polled communications network as claimed in any preceding Claim, wherein the slave units have been moved between a plurality of communications networks, loss of communications with the original master unit is automatically detected and the slave units subsequently respond to the log-on request message generated by the master unit of the new communications network.

24. A polled communications network as claimed in any preceding Claim; wherein, when the slave units have been moved between a plurality of communications networks the slave units automatically detect the change in identity of the master unit and subsequently respond to the log-on request message generated by the new master unit.

25. A polled communications network substantially as hereinbefore described with reference to Figures 2 to 5 of the accompanying drawings.

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Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

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(ii) Int Cl (Edition 5) H04Q H04L

Search Examiner
M J DAVIS

Databases (see over)
(i) UK Patent Office

(ii)

Date of Search
9 DECEMBER 1992

Documents considered relevant following a search in respect of claims 1-25

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2176639 A	(MARS) especially page 3 lines 25-86 page 5 line 59 to page 6 line 5	1-4, 16-18, 20-22

Category	Identity of document and relevant passages	Relevant to claim(s)
	15	

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

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P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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Applicant: Churt et al.

Lerner Greenberg Stemer LLP
Post Office Box 2480
Hollywood, FL 33022-2480
Tel: (954) 925-1100 Fax: (954) 925-1101